INDOOR AIR QUALITY ASSESSMENT

High School of Commerce
415 State Street
Springfield, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of Lynn Rose from the Western Massachusetts Coalition for Occupational Safety and Health (MassCOSH), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) was asked to provide assistance and consultation regarding indoor air quality at the High School of Commerce (HSC), 415 State Street, Springfield, Massachusetts. A series of visits were made to the HCS by Michael Feeney, Chief of Emergency Response/Indoor Air Quality (ER/IAQ), BEHA, to conduct indoor air quality assessments on September 26, 2001; November 9, 2001 and February 28, 2002. Mr. Feeney was accompanied by Robert Mulcahey, Chief of Maintenance of the HCS on all three days. Ms. Rose accompanied Mr. Feeney on September 26, 2001. Judy Deane of the American Lung Association accompanied Mr. Feeney on November 9, 2001 and February 28, 2002. Both Cory Holmes and Suzan Donahue, of the MDPH, BEHA, ER/IAQ Program assisted Mr. Feeney with air sampling on February 28, 2002. Concerns about symptoms attributed to boiler room pollutants in classrooms along the B34 to B39 corridor originally prompted the assessment.

The school is a three-story brick building constructed in 1915. As originally constructed, the building was in the shape of a rectangle, with the interior formed by an airshaft. A separate three story, redbrick building was constructed adjacent to the 1915 building in 1998. The 1915 building contains classrooms, library, cafeteria, auditorium and offices. The interior of the building underwent a total renovation in 1998, with installation of a sprinkler system, wiring and new heating, ventilating and air conditioning (HVAC) system. A roof was constructed over the interior airshaft that now forms the roof of the library. Floors were installed in the original gymnasium rear hallways of the basement and subbasement levels. The 1998 building contains science classrooms, gymnasium, weight room, exercise room, locker rooms and a swimming pool. The two buildings are connected by an elevated sheltered walkway (see Picture 1). The sash windows are openable in both buildings.

Methods

Air tests for carbon dioxide, temperature, relative humidity and carbon monoxide were taken with the TSI, Q-Trak ™, IAQ Monitor Model 8551 on February 28, 2002. Air tests conducted on November 9, 2001 for ultrafine particulates were taken with the TSI, P-Trak ™, Ultrafine Particle Counter Model 8525. Screening for total volatile organic compounds (TVOCs) was conducted in the vocational education wing using an HNu Systems, Photo Ionization Detector (PID). Outdoor background TVOC measurements were taken for comparisons.

Results

The school has a student population of approximately 1,575 and a staff of 200. The tests were taken during normal operations at the school. Test results appear in Tables 1-17.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million parts of air (ppm) in seven of twenty-seven areas surveyed on November 9, 2001 and forty-nine of one hundred ten areas surveyed on February 28, 2002. These air sampling results indicate a problem with fresh air supply in these areas of the HSC.

Fresh air in the 1915 building is supplied by a unit ventilator (univent) system in classrooms with windows. Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (see Picture 2) and return air through an air intake located at the base of each unit (see Figure 1). Fresh air and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit. Obstructions to airflow, such as books, papers and posters on top of univents, as well as bookcases, tables and desks in front of univent returns, were seen in a number of classrooms. To function as designed, univents and univent returns must remain free of obstructions. Importantly, these units must be activated and allowed to operate during hours of school occupation.

Fresh air supply in the library subbasement area, B34-B39 classrooms, B53-B57 hallway classrooms and the cafeteria in the 1915 building, as well as the entire 1998 building, is provided by ceiling mounted air handling units (AHUs) connected to ceiling or wall-mounted fresh air diffusers connected to ductwork.

Exhaust ventilation in the 1915 building is provided by ceiling mounted exhaust grilles in classrooms with windows. The configuration of the exhaust ventilation system in windowless 1915 classrooms and the 1998 building is provided by ceiling or wall-mounted exhaust grilles. Most exhaust vents examined during this assessment were operating.

Floor fans were being used in the gymnasium to increase air circulation. The placement of one fan directs air from the wall-mounted exhaust vent (see Picture 3). This placement directs air away from the exhaust vent, therefore decreasing the function of the ventilation system.

In order to have proper ventilation with a mechanical supply and exhaust system, all fresh air intakes and exhaust vents should remain unobstructed to allow for proper airflow; units must also be in working order and allowed to function as designed. In addition, the supply and exhaust ventilation systems should be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It was reported that the ventilation system has been balanced since the building opened in 1998. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches (see Appendix I).

Temperature readings ranged from 72° F to 76° F on November 9, 2001 and 69° F to 77° F on February 28, 2002, which were very close to or within the BEHA recommended guidelines. The BEHA recommends that indoor air temperatures be maintained in a range between 70 ° F to 78 ° F in order to provide for the comfort of building occupants. A number of temperature complaints were made by building occupants, which may indicate a problem with the heating system or thermostatic control. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. Temperature control is difficult in an old building without a functioning ventilation system.

The relative humidity in the building was below the BEHA recommended comfort range in all areas sampled. Relative humidity measurements ranged from 20 to 30 percent on November 9, 2001 and 13 to 25 percent on February 28, 2002. The BEHA recommends that indoor air relative humidity be maintained in a range of 40 to 60 percent for comfort purposes. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

A number of interior areas of the building had signs of water damage. Water damaged ceiling tiles were seen in these areas (see Picture 4), which are evidence of historic roof or plumbing leaks. Water damaged ceiling tiles can serve as a mold growth medium, and should be replaced after a water leak is discovered. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 hours of becoming wet (ACGIH, 1989). If these materials are not dried within this time frame, mold growth may occur. It appears that these materials were dried within this time frame.

Of note was the condition of the west exterior wall of the 1998 building. The presence of efflorescence (e.g., mineral deposits) on the exterior brickwork was noted beneath seams in cement block (see Picture 5). Efflorescence is a characteristic sign of water damage to brick and mortar, but it is not mold growth. As moisture penetrates and works its way through mortar around brick, water-soluble compounds in bricks and mortar dissolve, creating a solution. As this solution moves to the surface of the brick or mortar, the water evaporates, leaving behind white, powdery mineral deposits. It appears that the seams between cement blocks have deteriorated or were not installed (see Picture 6). Sealing these seams will prevent further damage and water intrusion.

Plants were noted in some classrooms. Plants can be a source of pollen and mold, and can be a respiratory irritant to some individuals. Plants should be properly maintained and equipped with drip pans. Plants should also be located away from univents to prevent the aerosolization of dirt, pollen or mold. Several classrooms contained plants in window planters. Window planters are designed to be mounted on the outside of windows and usually do not have drip pans. The lack of drip pans can lead to water pooling and mold growth on windowsills when used indoors. Windowsills, can be potentially colonized by mold growth and serve as a source of odors.

Other Concerns

A number of areas throughout the building demonstrated conditions that can result in the aerosolization of materials associated with irritant symptoms into the school environment. Classrooms in the 1915 building had a suspended ceiling installed during renovations. In order to not block windows, bays were built into the ceiling tile system. These bays have triangle-shaped tiles installed *vertically* (see Picture 7) in the sides of each bay to provide a continuous ceiling system. This configuration can lead to the triangular ceiling tiles falling into the ceiling plenum. A number of classrooms have triangular ceiling tiles that are ajar. Ceiling tiles, particularly those above univents, were found leaning into the ceiling plenum, which allows for air expelled from the univent to enter the space between the original and suspended ceilings (see Figure 2). Air forced into the ceiling plenum then pressurizes this space, which can then force air through spaces in the suspended ceiling. Through this pathway, particles in the air stream produced by the univent and that exist above the suspended ceiling can be directed towards the classroom interior. Dust, dirt and other particles can be irritating to the eyes, nose and throat.

Holes in the floor and spaces around pipes were noted within all univent cabinet interiors surveyed (see Picture 8 and 9). Open pipes and spaces around pipes can serve as pathways for dust, dirt, odors and other pollutants to move from the floor/wall cavities into the cabinet of the univent. Once inside the univent cabinet, these pollutants can then be drawn into the univent airflow and expelled into the classroom.

Each univent is also outfitted with a filter. Filters were either undersized or did not fit properly into racks, which results in unfiltered return air being redistributed into the classroom during univent operation. Frames of filters in rooftop AHUs were cut in order to fit inside the cabinet (see Picture 10). Filters that are cut in this manner degrade the ability of the filters to function as designed. This can result in dust, dirt and other debris being distributed by the ventilation system.

Univents and AHUs are equipped with filters that strain particulates from airflow. In order to decrease aerosolized particulates, disposable filters with an increased dust spot efficiency can be installed. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) to meet its standard for a dust spot efficiency of a minimum of 40 percent would be sufficient to reduce airborne particulates (Thornburg, D., 2000; MEHRC, 1997; ASHRAE, 1992). Note that increased filtration can reduce airflow produced by the unit by increased resistance (called pressure drop). Prior to any increase of filtration, each univent and AHU should be evaluated by a ventilation engineer to ascertain whether they can maintain function with more efficient filters.

Chemicals were stored in a storeroom on the third floor of the 1998 building. Of note was the condition of a jar of sodium metal found stored in the flameproof cabinet. A ring of fluid was noted beneath this bottle, which indicates that the liquid inside the container is escaping (see Picture 12). Sodium metal is water reactive (NFPA, 1991) and is an extreme fire hazard. This material must be stored in a non-water liquid to prevent moist air from contacting the surface of this material. The conditions of the container can lead to the eventual drying of the storage liquid and exposure of sodium to the air, which is unacceptable for this material. It is highly recommended that a thorough inventory of chemicals in the science department be done to assess chemical storage and disposal in an appropriate manner consistent with Massachusetts hazardous waste laws.

Many areas contain photocopiers. VOCs and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). Photocopiers and computer equipment also give off excess heat. Mechanical exhaust ventilation should be activated in these areas. Without mechanical exhaust ventilation, excess heat, odors and pollutants produced by office equipment can build up.

Accumulated chalk dust was noted in many classrooms. Chalk dust is a fine particulate, which can be easily aerosolized and serve as an eye and respiratory irritant. Several classrooms contained dry erase boards and markers. Materials such as dry erase markers and cleaners may contain VOCs, (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can also serve as a respiratory irritant for some individuals. Exposed fiberglass pipe insulation was also noted in several classrooms, restrooms and hallways throughout the school. Airborne fiberglass particles can serve as a skin and respiratory irritant to sensitive individuals.

Hallway B31-B39

In an effort to identify possible sources of environmental pollutants in Hallway B31-B39, a series of air tests were conducted in classrooms along this hallway. This air monitoring was conducted to identify whether products of combustion or other pollutants were penetrating into these classrooms from the boiler room. Air sampling was conducted for the following materials:

- Carbon monoxide
- Flammable gases
- Total Volatile organic compounds (TVOCs)
- Hydrogen sulfide
- Ultrafine particles

The classrooms share a wall with the mechanical room that contains the HSC boilers. No detectable levels of carbon monoxide, flammable gases or hydrogen sulfide were detected in any area within the HSC.

BEHA staff conducted air testing for TVOCs and ultrafine particles in the B-31-B38 classrooms at a number of locations (e.g., around electrical outlets, light switches, the center of the room, doorframes, vents) that can serve as sources or pathways for these pollutants. No measurable levels of TVOCs were detected in any area classrooms.

Using carbon monoxide to detect sources of combustion pollutants has a major drawback. If the source of combustion pollutants is allowed to dilute in a large volume of air within a building, carbon monoxide concentrations may decrease below the detection limits of equipment. The process of combustion produces airborne liquids, solids and gases (NFPA, 1997). The measurement of airborne particulates, in combination with carbon monoxide measurements can be used to pinpoint the source of combustion products. Measurements for ultrafine particulates (particles measuring 0.02 μm to 1 μm in diameter) were made. These results indicated no unusual source of for ultrafine particulates in this area.

While air monitoring did not identify pollutants that were migrating into these classrooms, several conditions were noted that might provide a source of odors and irritants.

- The elevator has an odor of hydraulic fluid that may be an irritating odor. The action of the elevator car moving within its shaft can create a piston-like action that may draw odors to higher levels in the building. Classrooms closest to the elevator shaft would be the most likely effected.
- Classrooms on this hallway do not have openable windows and are entirely reliant on the AHU to provide fresh air. The AHU servicing this area has experienced problems, resulting in periodic shutdown. With the AHU deactivated, normally occurring pollutants may build up to make room occupants uncomfortable.
- Accumulated chalk dust was noted in several classrooms. Chalk dust is a fine particulate, which can become easily aerosolized and serve as a source of eye and respiratory irritation.
- The shared wall between classrooms has a number of penetrations, which may serve as pathways for migration of boiler room pollutants into the wall cavity of these classrooms.
- As noted in other AHUs, the practice of cutting filters may allow for outdoor pollutants to be entrained by and distributed to classrooms via the AHU.

Each of these circumstances may provide a means for pollutants associated with irritant symptoms to enter these classrooms.

Bird Nesting

Bird wastes were observed beneath a space between the elevated walkway and its junction with the 1915 building (see Picture 11). The space at this junction allows for birds to roost inside the building envelope in this area. Bird wastes in a building raise three concerns: 1) diseases that may be caused by exposure to bird wastes, 2) the need for clean up of bird waste and 3) appropriate disinfection.

Certain molds are associated with bird wastes and are of concern for immune compromised individuals. Other diseases of the respiratory tract may also result from chronic exposure to bird wastes. Exposure to bird wastes are thought to be associated with the development of hypersensitivity pneumonitis in some individuals. Psittacosis (bird fancier's disease) and histoplasmosis are other conditions closely associated with exposure to bird wastes in either the occupational or bird raising setting. While immune compromised individuals have an increased risk of health impacts following exposure to the materials in bird wastes, these impacts may also occur in healthy individuals exposed to these materials.

The methods to be employed in clean up of a bird waste problem depend on the amount of waste and the types of materials contaminated. The MDPH has been involved in several indoor air investigations where bird waste has accumulated within ventilation ductwork (MDPH, 1999). Accumulation of bird wastes have required the clean up of such buildings by a professional cleaning contractor. In less severe cases, the cleaning of the contaminated material with a solution of sodium hypochlorite (bleach) has been an effective disinfectant (CDC, 1998). Disinfection of non-porous materials can be readily accomplished with this material. Porous materials contaminated with bird waste should be examined by a professional restoration contractor to determine if the material is salvageable. Where a porous material has been colonized with mold, it is recommended that the material be discarded (ACGIH, 1989).

The protection of both the cleaner and other occupants present in the building must be considered as part of the overall remedial plan. Where cleaning solutions are to be used, the "cleaner" is required to be trained in the use of personal protective methods and equipment (to prevent either the spread of disease from the bird wastes and/or exposure to cleaning chemicals). In addition, the method used to clean up bird waste may result in the aerosolization of particulates that can spread to occupied areas via openings (doors, etc.) or by the ventilation system. Methods to both prevent the spread of bird waste particulates to occupied areas or into ventilation ducts must be employed. In these instances, the result can be similar to the spread of renovation-generated dusts and odors in occupied areas. To prevent this the cleaner should employ the methods listed in the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Guidelines for Containment of Renovation in Occupied Buildings (SMACNA, 1993).

Conclusions/Recommendations

In view of the findings at the time of the inspection, the following recommendations are made:

1. Remove birds' nests from the walkway and seal with wire mesh or other appropriate materials. Implement the corrective actions recommended concerning remediation of bird wastes.
2. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy independent of classroom thermostat control.
3. Examine each univent for function. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers school-wide.
4. Thermostat settings throughout the complex should be evaluated. Thermostats should be set at temperatures to maintain comfort for building occupants.
5. Remove all blockages from univents and exhaust vents to facilitate airflow.
6. Once both the fresh air supply and exhaust ventilation are functioning, the systems should be balanced by a ventilation engineer.
7. Render airtight all open pipes and spaces around pipes in univent cabinets.
8. Seal holes in univent cabinet walls in contact with airflow to prevent draw of air into post-filter airstream.
9. Repackage material in Picture 12 to an airtight container.
10. Examine options for fixing vertical, triangular ceiling tiles in place.

11. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be implemented. This will minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. Use of vacuum cleaning equipment outfitted with a high efficiency particulate arrestance filter (HEPA) is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

12. Move plants away from univents in classrooms. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary. Consider discontinuing the use of window planters inside the building. Examine windowsills beneath window planters for water damage and microbial growth. If wooden windowsills are colonized with mold growth, replacement of windowsill should be considered.

13. Have a chemical inventory done in all storage areas and classrooms. Properly store flammable materials in a manner consistent with the local fire code. Discard hazardous materials or empty containers of hazardous materials in a manner consistent with environmental statutes and regulations. Label chemical containers with the chemical name of its contents. Follow proper procedures for storing and securing hazardous materials.

14. Obtain Material Safety Data Sheets (MSDS) for chemicals from manufacturers or suppliers. Maintain these MSDS' and train individuals in the proper use, storage and protective measures for each material in a manner consistent with the Massachusetts Right-To-Know Law, M.G.L. c. 111F (MGL, 1983).

15. Seal utility holes and wall cracks to prevent the egress of dirt, dust and particulate matter between rooms and floors.

16. Change filters for air-handling equipment as per the manufacture's instructions or more frequently if needed. Vacuum interior of univents prior to activation to prevent the aerosolization of dirt, dust and particulates. Ensure filters fit flush in their racks with no spaces in between allowing bypass of unfiltered air into the unit. Obtain air filter brackets to prevent air-bypass if multiple filters are installed in one rack.

17. Clean chalkboards and chalk trays regularly to prevent the build-up of excessive chalk dust.

18. Examine the feasibility of re-pointing the seams of cement blocks on exterior wall of the 1998 building.

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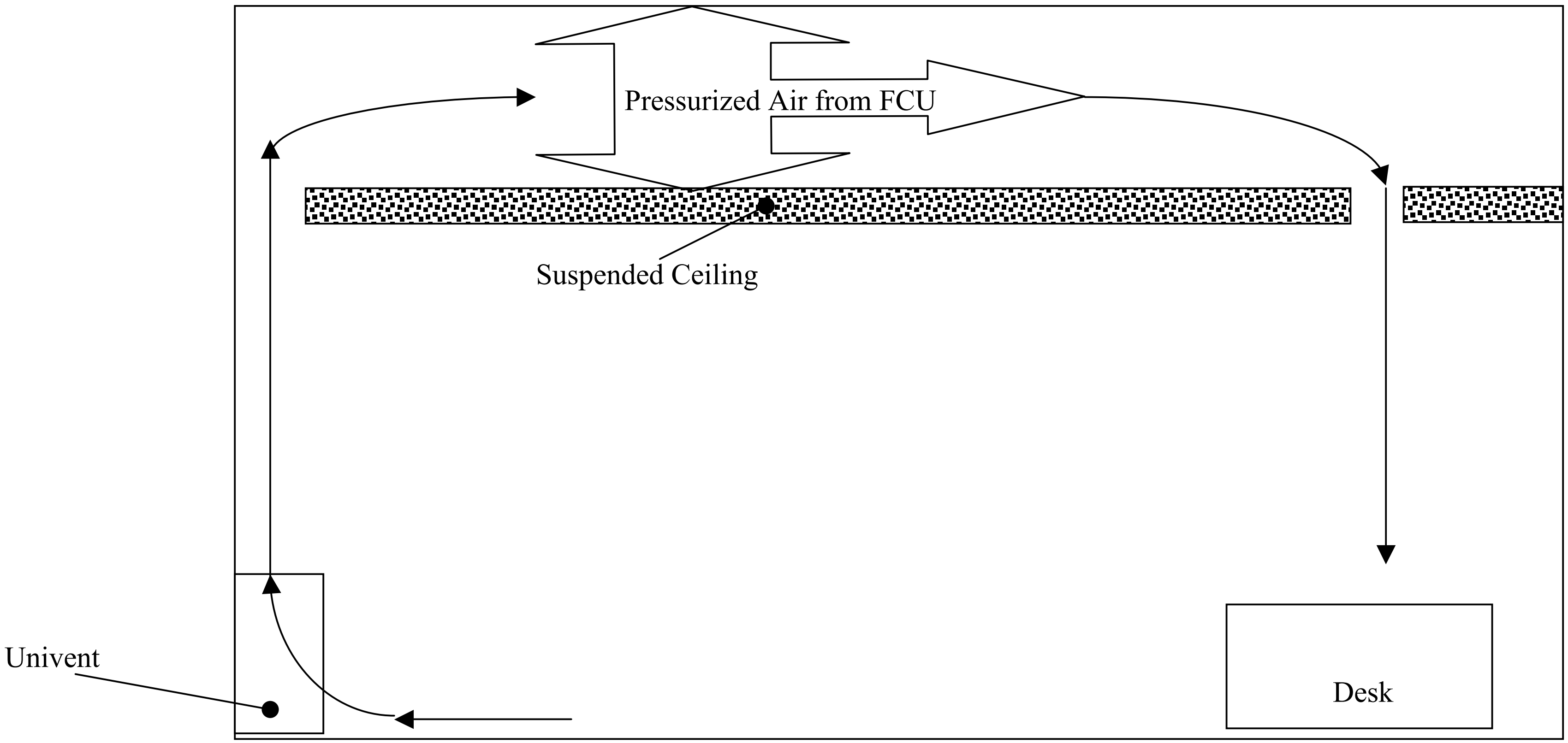
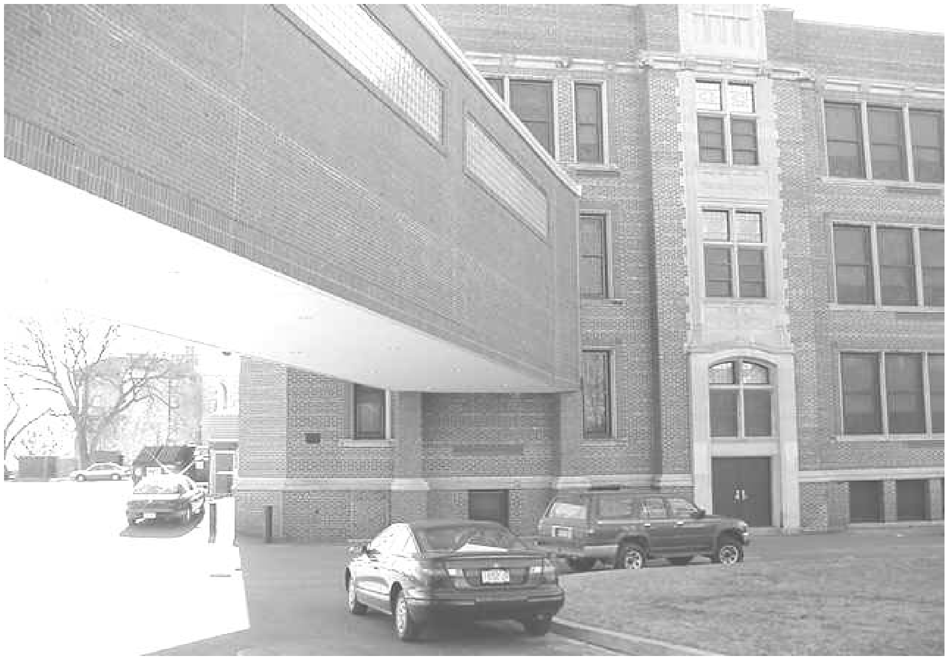
Figure 2
Pressurization of Ceiling Plenum in Classrooms



Picture 1

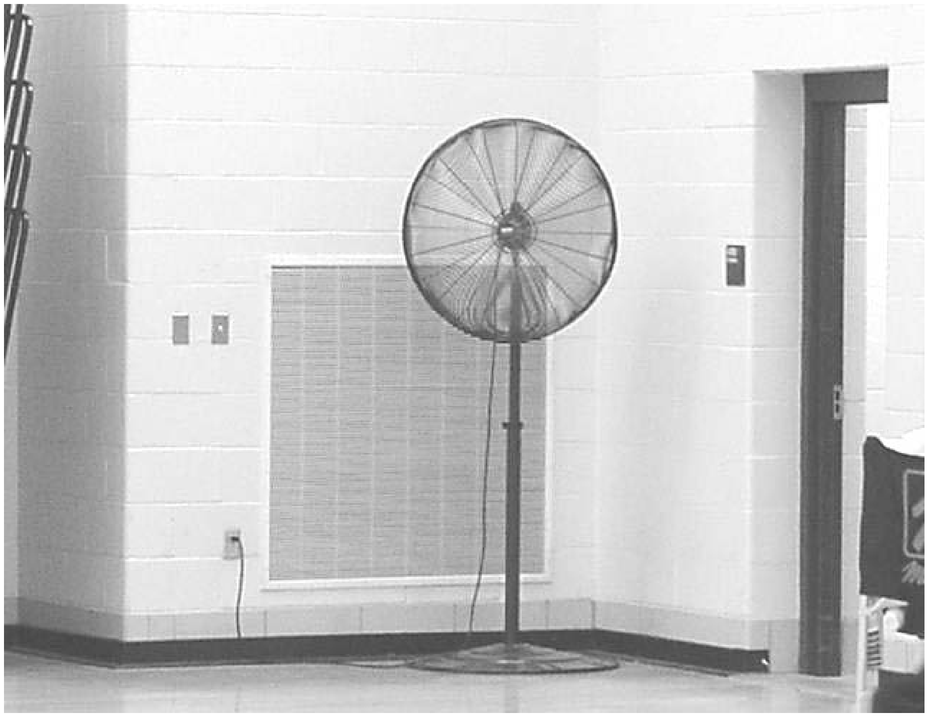


Elevated Walkway

Picture 2

Exterior Wall Fresh Air Intakes

Picture 3



Floor Fan in Front of Exhaust Vent in Gymnasium

Picture 4

Water Damaged Ceiling Tile

Picture 5

Efflorescence (E.G., Mineral Deposits) on The Exterior Brickwork was Noted Beneath Seams in Cement Block

Picture 6

The Seams between Cement Blocks

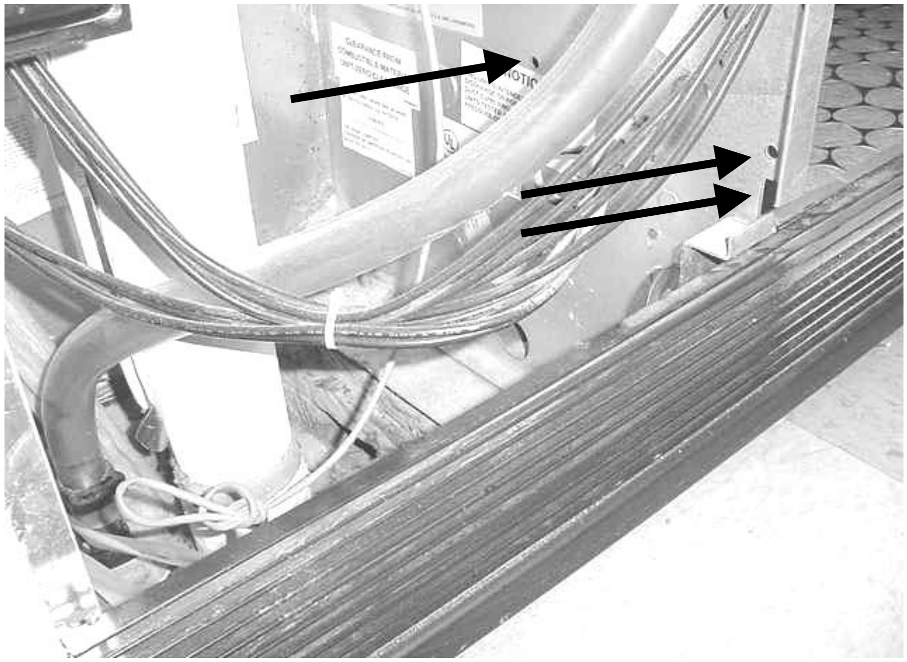
Picture 7

Triangle-Shaped Tiles Installed *Vertically* into Ceiling System

Picture 8

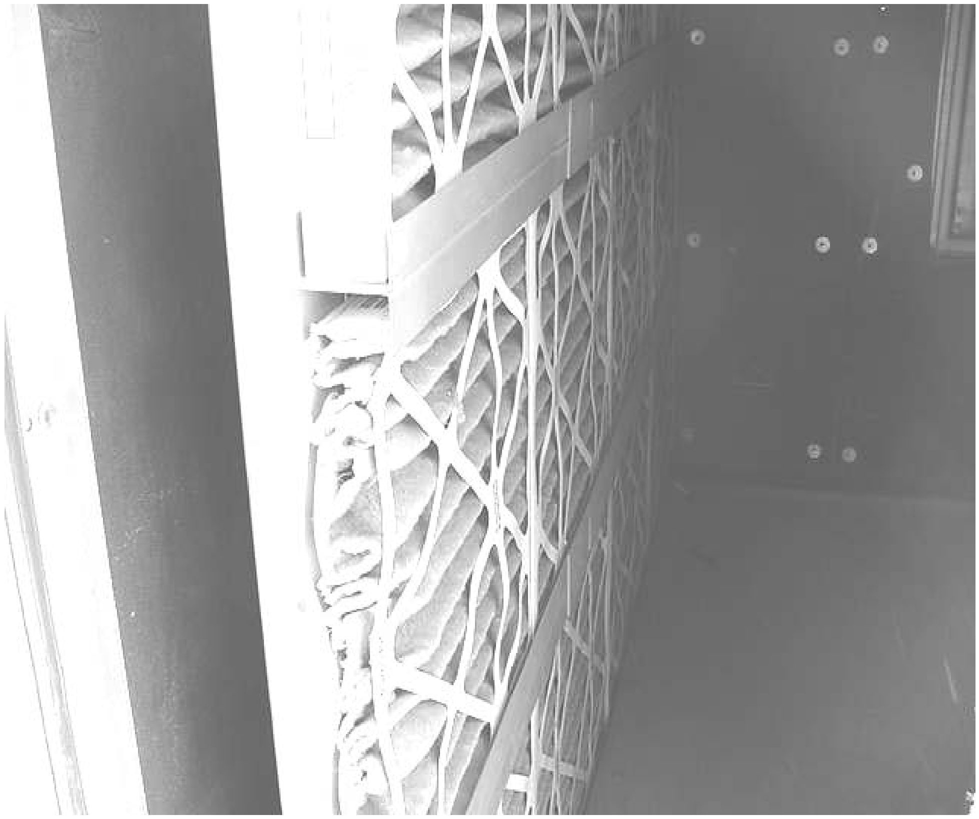
Holes in the Floor and Spaces around Pipes Were Noted Within All Univent Cabinets

Picture 9



Holes in Cabinet Wall Post Filter (See Arrows)

Picture 10



Filters Cut To Fit inside Cabinet

Picture 11

Bird Nests Underneath Elevated Walkway, Note Univent Fresh Air Intake below Bird Waste

Picture 12

Sodium Metal With Liquid Leaking from Container

TABLE 1

Indoor Air Test Results – High School of Commerce, Springfield, MA – November 9, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Outside (Background)	378	50	28					
A-222	810	73	24	20	Yes	Yes	Yes	Window open
A-3rd Floor Hallway (outside 306)	699	72	24	5	No	Yes	Yes	1 water-damaged CT
A-310	787	74	25	14	Yes	Yes	Yes	
Greenhouse								Floor drain, weather strip-door
A-308	752	74	24	0	Yes	Yes	Yes	
B-327	753	74	25	1	Yes	Yes	Yes	Window open
B-326	835	75	24	15	Yes	Yes	Yes	
Hallway – B-39	692	72	26	3	No	Yes	Yes	2 water-damaged CT
B-38	701	73	26	20	No	Yes	Yes	Chalk dust
B-35	548	72	23	8	No	Yes	Yes	Dry erase board

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – High School of Commerce, Springfield, MA – November 9, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
B-34	562	72	24	4	No	Yes	Yes	2 water-damaged CT, chalk dust
B-17	1232	73	29	13	No	Yes	Yes	1 water-damaged CT
B-57	570	72	23	0	No	Yes	Yes	
B-26	920	72	28	0	No	Yes	Yes	Dry erase board
B-56	730	73	25	20	No	Yes	Yes	Chalk dust, dry erase board/cleaner
B-55	675	72	24	18	No	Yes	Yes	
B-54	691	72	24	18	No	Yes	Yes	
Cafeteria	87	74	28	500+	No	Yes	Yes	
B-53	773	73	24	21	No	Yes	Yes	
Hallway B-58	733	73	25	0	No	Yes	Yes	
B-51	1376	73	30	18	No	Yes	Yes	Chalk dust

*** ppm = parts per million parts of air**
CT = ceiling tiles

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TABLE 3

Indoor Air Test Results – High School of Commerce, Springfield, MA – November 9, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Library	730	73	28	10	No	Yes	Yes	27 computers, fad-dust, door open
B-146	626	73	23	17	Yes	Yes	Yes	30 computers, missing CT, window open
Hallway 147	893	74	26	0	No	Yes	Yes	
B-325	766	76	25	11	Yes	Yes	Yes	Window open, plants over univent, 30 computers
Gym South	534	75	21	12	No	Yes	Yes	Floor fan-exhaust
Gym North	531	73	20	26	No	Yes	Yes	Floor fan-exhaust
A-223	802	73	23	21	Yes	Yes	Yes	plants

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results –High School of Commerce, Springfield, MA – November 9, 2001

Location	TVOCs *ppm	Ultrafine Particulates **p/cc	Comments
Outside (Background)	0.5	13,300	
A-222	0.5	3,600	
3rd Floor Hallway (outside 306)	0.5	4,000	
A-308	0.5	4,100	
B-327	0.5	10,500	
B-326	0.5	10,700	
Hallway (outside B-39)	0.5	5,000	
B-38	0.5	4,800	
B-35	0.5	4,500	
B-34	0.5	4,800	
B-17	0.5	2,600	

*** ppm = parts per million parts of air**
**** p/cc = particles per cubic centimeter of air**

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 5

Indoor Air Test Results –High School of Commerce, Springfield, MA – November 9, 2001

Location	TVOCs *ppm	Ultrafine Particulates **p/cc	Comments
B-57	0.5	4,700	
B-26	0.5	800	
B-56	0.5	4,100	
B-55	0.5	4,700	
B-54	0.5	4,800	
Cafeteria	0.5	3,000	
B-53	0.5	4,100	
Hallway B-58	0.5	3,900	
B-51	0.5	3,700	
Library	0.5	2,300	
B-146	0.5	4,600	

*** ppm = parts per million parts of air**
**** p/cc = particles per cubic centimeter of air**

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 6

Indoor Air Test Results –High School of Commerce, Springfield, MA – November 9, 2001

Location	TVOCs *ppm	Ultrafine Particulates **p/cc	Comments
Hallway 147	0.5	4,700	
B-325	0.5	3,300	
Gym South	0.5	6,200	
Gym North	0.5	5,000	
A-223	0.5	7,600	

*** ppm = parts per million parts of air**
**** p/cc = particles per cubic centimeter of air**

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred 600 - 800 ppm = acceptable > 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 7

Indoor Air Test Results – High School of Commerce, Springfield, MA – February 28, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	369	45	13					Blustery
B-331	1130	74	20	4	Yes	Yes		
B-333	844	75	20	9	Yes	Yes	Yes	Items on univent
B-335	739	76	18	1	Yes	Yes	Yes	Plants
B-339	592	73	15	1	Yes	Yes	Yes	Plants on univent
B-345 Art Room	738	72	17	1	Yes	Yes	Yes	Temperature complaints-cold
B-301	770	71	17	17	Yes	Yes	Yes	Univent return blocked by cart
Darkroom	752	72	17	2	No		Yes	Local exhaust vent-not used
B-309	667	71	15	13	Yes	Yes	Yes	1 out of 2 univents off, drafts
B-327	550	71	14	6	Yes	Yes	Yes	
038	754	74	17	6	No	Yes	Yes	Chalk dust, door open

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 8

Indoor Air Test Results – High School of Commerce, Springfield, MA – February 28, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
035	755	74	18	18	No	Yes	Yes	Dry erase board
B37 Teacher's Room	634	74	17	0	No	Yes	Yes	1 water-damaged CT
B34	791	74	18	9	No	Yes	Yes	2 water-damaged CT
B26	957	73	17	18	No	Yes	Yes	Dry erase board
Library	670	73	20	13	No	Yes	Yes	
Gymnasium	562	74	14	40+	No	Yes	Yes	
Gymnasium	546	74	15	16	No	Yes	Yes	
A-304	766	74	17	8	No	Yes	Yes	1 water-damaged CT, door open
Pool	515	77	36	0	No	Yes	Yes	
A-116	478	76	16	1	No	Yes	Yes	
327	972	75	26	24	Yes	Yes	Yes	Temperature complaints-heat, dust accumulation, door open

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 9

Indoor Air Test Results – High School of Commerce, Springfield, MA – February 28, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
231	843	75	18	10	Yes	Yes	Yes	Plant, door open
237	623	74	15	5	Yes	Yes	Yes	Chalk dust
229	698	72	16	14	Yes	Yes	Yes	Chalk dust
B-221	740	74	17	1	Yes	Yes	Yes	Chalk dust
B-215	864	75	18	2	Yes	Yes	Yes	Window open, stuffy/hot
B-219	1038	76	19	12	Yes	Yes	Yes	Little/no airflow at exhaust vent
B-211	639	75	16	1	Yes	Yes	Yes	1 water-damaged CT, temperature complaints-cold, door open
B-253	899	75	17	6	Yes	Yes	Yes	2 univents-covered by books/items
B-151	582	75	15	4	Yes	Yes	Yes	Plants
B-145 Computer Room	592	74	13	2	Yes	Yes	Yes	2 univents, 25 computers, window open, temperature complaints-heat
135 Health Suite	812	75	17	7	Yes	Yes	Yes	

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 10

Indoor Air Test Results – High School of Commerce, Springfield, MA – February 28, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
140 Reception	865	75	18	2	No	Yes	Yes	
129	1087	75	18	19	Yes	Yes	Yes	
B-119	940	75	18	10	Yes	Yes	Yes	
B-115	780	74	19	3	Yes	Yes	Yes	Univent covered with books, temperature complaints-heat
B-181 Guidance	773	74	17	15-20				
Conference Room	637	73	16	2	Yes	Yes	Yes	
179 Office	777	73	17	1	Yes	Yes	Yes	Door open
177	733	73	18	0	No	Yes	Yes	
B-49	809	75	15	14	Yes	Yes	Yes	Univent covered with books, 10-15 plants, chalk dust, complaints of sewer gas odors in morning
B-51	928	75	17	13	Yes	Yes	Yes	Chalk dust

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 11

Indoor Air Test Results – High School of Commerce, Springfield, MA – February 28, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
B-61	700	72	15	7	Yes	Yes	Yes	
Band Room	472	70	14	0	Yes	Yes	Yes	Temperature complaints
B-53	693	72	14	14	Yes	Yes	Yes	Chalk dust
B-055	664	72	16	18	Yes	Yes	Yes	Complaints of stuffiness/headaches on Mondays
B-17	986	73	17	15	Yes	Yes	Yes	1 water-damaged CT
A-223	770	71	16	12	Yes	Yes	Yes	~10 plants
A-221	865	71	16	15	Yes	Yes	Yes	
A-219	866	71	19	13	Yes	Yes	Yes	Items stored in lab hood, bunsen burners in use, door open
A-307	830	72	17	11	Yes	Yes	Yes	
A-311	930	72	18	15	Yes	Yes	Yes	Chalk dust, door open
A-125 Exercise Room	648	71	18	8	No	Yes	Yes	3 missing CT, 3 water-damaged CT

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 12

Indoor Air Test Results – High School of Commerce, Springfield, MA – February 28, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
A-224	1156	72	20	19	Yes	Yes	Yes	5 computers, eyewash, chalk dust
A-212	866	74	19	3	No	Yes	Yes	Photocopier, restroom, refrigerator
A-222	988	72	19	15	Yes	Yes	Yes	5 computers, chalk dust, plant
A-220	671	69	16	4	Yes	Yes	Yes	Window open, chalk dust, plants
B-308	938	73	20	17	Yes	Yes	Yes	Chalk dust, incubator, vent hood, dishwasher
Greenhouse (off B-308)				0	No	No	Yes	Door open to classroom
310	976	74	19	18	Yes	Yes	Yes	Chalk dust, 5 computers
A-110 Health Room	957	73	19	14	No	Yes	Yes	Dry erase board
Team Locker Room	474	71	14	0	No	Yes	Yes	Floor drains
Girl's Locker Room	585	73	16	~24	No	Yes	Yes	Floor drains
128	909	74	18	7	Yes	Yes	Yes	5 computers

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CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 13

Indoor Air Test Results – High School of Commerce, Springfield, MA – February 28, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
120	565	74	16	4	Yes	Yes	Yes	4 computers, chalk dust
B-50	810	74	17	18	Yes	Yes	Yes	Books on univent, dry erase board, dislodged CT, missing CT, 5 computers
B-64 Faculty Dining	776	73	20	7	Yes	Yes	Yes	~12 plants, warming trays, refrigerator, sink, door open
Cafeteria	704	74	20	~35	No	Yes	Yes	ROTC training
B-54	705	73	17	7	No	Yes	Yes	5 computers, door open chalk dust
B-16	934	75	18	13	Yes	Yes	Yes	19 computers, water-damaged CT, dislodged CT, dry erase board
B-56	785	74	18	19	No	Yes	Yes	Dry erase board
332	770	74	19	18	Yes	Yes	Yes	4 computers, 4 plants-2 over univent, dry erase board, door open
340	704	72	17	8	Yes	Yes	Yes	3 computers, cleaner on desk, dry erase board, very happy teacher

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 14

Indoor Air Test Results – High School of Commerce, Springfield, MA – February 28, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
342	1026	74	21	8	Yes	Yes	Yes	Window slightly open, plant-standing water in drip pan, 4 computers, chalk dust
302	688	70	17	7	Yes	Yes	Yes	5 computers, 2 plants, 3 water-damaged CT, missing CT, dry erase board
320 Consumer Science	843	72	25	15	Yes	Yes	Yes	2 gas stoves-4 electric stoves, 18 plants, dry erase board, water concerns-copper
330	1346	73	22	17	Yes	Yes	Yes	5 missing CT, chalk dust
326	989	75	21	13	Yes	Yes	Yes	6 computers, 2 missing CT, chalk dust, dry erase board
230	647	77	16	9	Yes	Yes	Yes	5 computers, chalk dust, dry erase board
228	525	74	16	1		Yes	Yes	5 computers, dry erase board, chalk dust
222	1012	73	19	20	Yes	Yes	Yes	4 computers, chalk dust
B-220	612	74	17	2	Yes	Yes	Yes	5 computers, missing CT, chalk dust

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CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 15

Indoor Air Test Results – High School of Commerce, Springfield, MA – February 28, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
210	727	74	18	0	Yes	Yes	Yes	5 occupants gone <5 mins., 7 plants-4 over univent, 5 computers, chalk dust, dry erase board
206	835	74	18	8	Yes	Yes	Yes	Items on univent, 5 computers, chalk dust
146	691	71	16	21	Yes	Yes	Yes	30 computers, missing CT, book-bag on univent, dry erase board
150	1127	74	20	13	No	Yes	Yes	Dry erase board
TV Room	1060	72	19	0	No	Yes	Yes	Dry erase board, cameras
Control Room	1052	73	19	2	No	Yes	Yes	3 computers
Office	1053	73	20	0	Yes	Yes	Yes	6 plants, door open, carpet
148	1546	75	22	10	Yes	Yes	Yes	Window slightly open, chalk dust, dry erase board, 5 computers, water-damaged CT, dislodged CT
B-244	756	73	19	4	Yes	Yes	Yes	

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Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
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	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 16

Indoor Air Test Results – High School of Commerce, Springfield, MA – February 28, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
B-249	524	72	17	1	Yes	Yes	Yes	
B-250	1058	72	19	19	Yes	Yes	Yes	Chair obstructing univent, chalk dust
B-251	1044	72	21	8	Yes	Yes	Yes	Chalk dust
B-252	1043	73	20	12	Yes	Yes	Yes	Dry erase board
B-154	926	74	18	19	Yes	Yes	Yes	Chalk dust
B-156	725	74	17	11	Yes	Yes	Yes	Chalk dust
B-157	1178	74	19	12	Yes	Yes	Yes	Books, plants
B-158	654	74	16	4	Yes	Yes	Yes	
B-159	931	73	19	11	Yes	Yes	Yes	Coat on univent, chalk dust
B-169	721	73	17	10	Yes	Yes	Yes	Book on univent, chalk dust
B-170	902	72	18	9	Yes	Yes	Yes	Chalk dust

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 17

Indoor Air Test Results – High School of Commerce, Springfield, MA – February 28, 2002

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation Intake	Ventilation Exhaust	Remarks
Main Office	808	74	21	9	Yes	Yes	Yes	
Auditorium	534	70	17	0	Yes	Yes	Yes	
181	740	71	20	6	Yes	Yes	Yes	
B-325	717	73	18	8	Yes	Yes	Yes	Window open, several plants, 3 missing CT
B-323	627	75	17	1	Yes	Yes	Yes	1 missing CT, 1 dislodged CT, dry erase board, chalk dust
B-240	583	74	15	8	Yes	Yes	Yes	20 computers, dry erase board
B-241	685	73	16	9	Yes	Yes	Yes	
B-242	942	73	18	16	Yes	Yes	Yes	Cardboard blocking supply, dust
B-243	1124	72	18	22	Yes	Yes	Yes	Coat on univent, chalk dust

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%